



Titratable acidity increase during fermentation

A previous Ask the AWRI column (Issue 608) described various aspects of acidity and briefly discussed the phenomenon of titratable acidity (TA) increase during fermentation. In this column, Adrian Coulter responds to more specific questions received by the AWRI helpdesk about TA increases due to acid production by yeast, without any evidence of spoilage.

What acids do yeasts produce during fermentation?

Wine yeasts can produce various acids during fermentation, including oxo and hydroxy acids such as pyruvic and α -ketoglutaric acids, organic acids such as succinic, malic and lactic acids, and various fatty acids, such as acetic acid, octanoic and decanoic acids. However, the concentration of each of these acids found in wine straight after fermentation is typically less than 500 mg/L, with the exception of succinic acid, which can be present in amounts up to 2 g/L (Radler 1992).

The AWRI's helpdesk has consistently found succinic acid to be responsible for noticeable TA increases observed during fermentation, with up to 3 g/L of succinic acid detected in such wines (Coulter *et al.* 2004).

What is the average concentration of succinic acid in Australian wines?

Analysis of 93 red wines and 45 white wines submitted to AWRI Commercial Services between 1991 and 2003 showed the mean concentration of succinic acid in Australian white and red wines to be 0.6 g/L and 1.2 g/L, respectively (Coulter *et al.* 2004). More recently, a survey of



277 red and white wines analysed by the same laboratory between 2011 and 2015 showed both the mean and median concentrations of succinic acid to be approximately 1.2 g/L, with a maximum concentration of 3.1 g/L (Wilkes 2016).

Which factors influence succinic acid production during fermentation?

There are many possible factors that might influence the amount of

succinic acid produced by yeast during fermentation. These are related both to the composition of the grape berry and the enzymatic composition of the yeast cell at the time of inoculation, which itself may be affected by how the yeast is prepared (e.g. rehydrated from active dried wine yeast or propagated from a yeast slope) and winemaking variables. Some important factors and their impact on the production of succinic acid are summarised in Table 1 (see over). ▶

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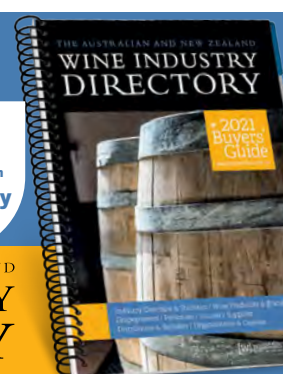
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If yeasts produce succinic acid during fermentation, why does the TA usually go down?

Grapes contain significant quantities of tartaric acid and potassium, which results in a high concentration of dissolved potassium bitartrate (KHT). As ethanol is produced during fermentation, the wine becomes supersaturated with KHT, which tends to form crystals and precipitate. When average concentrations of succinic acid are produced, increases in TA are typically not observed due to the overall decrease in total acidity resulting from this precipitation of KHT. However, when higher-than-average concentrations of succinic acid are produced, the decrease in TA due to KHT precipitation does not always compensate for the increase due to succinic acid and this is when TA increases are noticed.

Is it true succinic acid has a bitter, salty taste?

Succinic acid has been reported to have an 'unusual salty, bitter taste' and this was confirmed by Coulter *et al.* (2004) during tastings of solutions of succinic acid in water. Baroň and Fiala (2012) made additions of succinic acid to a white wine and also confirmed the 'salty', 'bitter' taste at higher addition rates. However, all the TA increases investigated by the AWRI's helpdesk have been associated with red wines, and while they have often tasted acidic before malolactic fermentation (MLF), they typically have not tasted 'salty' or 'bitter'. Generally,

Table 1. Summary of the impact of a range of factors and winemaking variables on the production of succinic acid during fermentation

Factor	Effect on succinic acid production
Yeast strain	Some strains produce more succinic acid, such as AWRI 796, AWRI 1152, AWRI 1578, Enoferm M2 ^{1,2} .
Fermentation temperature	Increasing temperature (up to 30°C) tends to favour succinic acid production ^{1,3} .
Nitrogen	Increased succinic acid production may occur with increasing nitrogen ^{1,3} .
Sugar	Increased sugar concentration might lead to increased production of succinic acid ^{1,3} .
Oxygen	Aeration may increase the amount of succinic acid produced ^{1,2,3} .
Vitamins	Increased levels of thiamine, biotin and pantothenate might lead to increased production of succinic acid ¹ , whereas a deficiency of nicotinic acid and/or nicotinamide may also lead to increased levels of succinic acid ³ .

Notes:

1. Coulter *et al.* (2004) 2. Contreras *et al.* (2015) 3. De Klerk (2010)

red wines affected by TA increase during fermentation tend to become balanced after MLF and barrel maturation, such that succinic acid concentrations up to 3 g/L do not necessarily have a negative impact on red wine flavour (Contreras *et al.* 2015, Coulter *et al.* 2004).

For further information on succinic acid and TA increases or any other technical grapegrowing or winemaking questions, contact the AWRI helpdesk on helpdesk@awri.com.au or 08 8313 6600.

References

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